**EGI-Engage**

Web portals for tsunami wave propagation simulations and for WRF-based weather simulation

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Abstract

This deliverable describes the first release of two simulation portals developed by the Disaster Mitigation Competence Centre during EGI-Engage: tsunami wave propagation simulation portal and weather simulation portal. The two portals provide stand-alone and ease-of-use simulation tools for entire life cycle of a tsunami event and numerical weather prediction respectively.

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**TERMINOLOGY**

A complete project glossary is provided at the following page: <http://www.egi.eu/about/glossary/>

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# Executive summary

This deliverable describes the first release of two simulation portals developed by the Disaster Mitigation Competence Centre (DMCC) during EGI-Engage: tsunami wave propagation simulation portal (iCOMCOT) and weather simulation portal (gWRF). The two portals provide compact and ease-to-use simulation tools for the full cycle of a tsunami event and numerical weather prediction.

DMCC aims to develop early warning system of disasters by deeper understanding of the target disasters via e-Science infrastructure. The weather simulation framework and tsunami simulation framework are used to investigate the target disaster cases by DMCC such as storm surge, floods, forest fire dust transportation and tsunami impact analysis in-depth. Web portal services are the best way to share the core facility of DMCC and to encourage engagement of wider user communities. The iCOMCOT and gWRF web portals support high performance simulation and significantly reduce the barrier of both grid and scientific complexities.

The portals are now open for researchers and will be used by the Disaster Mitigation Competence Centre of the EGI-Engage project to simulate to storm surge, flood, tsunami and forest fire dust transportation events from Philippine, Malaysia, Thailand and Taiwan. In parallel with this, Academia Sinica continues further development of the portals. In future releases the web portal services will integrate the interoperable authentication and authorization infrastructure based on EGI services, will be connected to the EGI accounting services, and will be extended with an event database as well as with an API to improve extendibility with custom applications and interfaces.

# Introduction

DMCC aims to achieve early warning system for target disasters by deeper understanding of disasters with e-Science approach. Based on better scientific models validated by historical events and observation data, faster simulation over the e-Infrastructure could earn more time for potential impacts estimation and quick response. Innovative model is devised by combining atmospheric model and ocean model for and higher resolution observation data of the whole life span of a disaster. Web portal is the best way to share the core tools of DMCC and to encourage engagement of wider communities.

By re-investigating historical events of selected disasters, scientist group, together with local partners, develops new models based on advanced science and high resolution event data from the local partner. Meanwhile, Web portal of the core simulation package is released to facilitate e-Science applications on natural hazards. Web Portal Services are also the key channel for dissemination of DMCC. DMCC e-Science reference architecture is depicted in Figure 1.

Figure 1. DMCC e-Science reference architecture

Web portal is a viable solution to support scientific community and application community to make effective use of distributed cloud services. Furthermore, via the ease-of-use simulation portals, more application workflows, use cases, application data sets, interdisciplinary collaborations and user communities could be explored. User feedback then directly facilitates the improvement of web portals and science gateways. Momentum of the mutual beneficial interactions thus advanced the values of disaster mitigation by e-Science.

The following two tables provide a summary of the portals covered in this deliverable.

Table 1

|  |  |
| --- | --- |
| **Tool name** | ***Tsunami simulation portal (iCOMCOT portal)*** |
| **Tool url** | [*https://icomcot.twgrid.org*](https://icomcot.twgrid.org) |
| **Description** | *iCOMCOT provides web portal services to simulate the entire lifespan of a tsunami, from its generation, propagation and runup/rundown on coastal regions, by the Cornell Multi-grid Coupled Tsunami Model (COMCOT).* |
| **Value proposition** | *The iCOMCOT web portal supports high performance simulation and significantly reduce the barrier of whole lifespan tsunami simulation.* |
| **Customer of the tool** | *Research projects on disaster mitigation or tsunami in Asia Pacific Grid Initiative (APGI) partners countries.* |
| **User of the service** | *Teachers, students, and scholars of research institutes or societies on hydrological and oceanic sciences, disaster mitigation, or earth science.* |
| **User Documentation**  | *https://documents.egi.eu/document/2784* |
| **Technical Documentation**  | *https://documents.egi.eu/document/2784* |
| **Product team** | *ASGC/AS* |
| **License** | *Apache License, Version 2.0* |
| **Source code** | [*https://github.com/hdyen/comcot*](https://github.com/hdyen/comcot) |

Table 2

|  |  |
| --- | --- |
| **Tool name** | ***Weather simulation portal (WRF portal)*** |
| **Tool url** | [*https://gwrf.twgrid.org*](https://gwrf.twgrid.org) |
| **Description** | *gWRF provides web portal services for numerical weather predication by the Weather Research and Forecasting (WRF) model developed by NCAR.* |
| **Value proposition** | *The gWRF web portal supports high performance simulation and significantly reduce the barrier of numeric weather analysis.* |
| **Customer of the tool** | *Research projects on disaster mitigation or extreme weather in Asia Pacific Grid Initiative (APGI) partners countries.* |
| **User of the service** | *Environmental science research group, individual researcher, teacher and student; Disaster mitigation community; Weather research and forecasting applications and service providers;* |
| **User Documentation**  | *https://documents.egi.eu/document/2784* |
| **Technical Documentation**  | *https://documents.egi.eu/document/2784* |
| **Product team** | *ASGC/AS* |
| **License** | *Apache License, Version 2.0* |
| **Source code** | [*https://github.com/yyr/wrf*](https://github.com/yyr/wrf) |

1. Service architecture

## High-Level Service architecture

According to the reference architecture of Figure 1, DMCC releases the web portal services on tsunami wave propagation simulation and the weather simulation. DMCC Web Portal Service aims to provide simulation services over the e-Infrastructure. Web portal is made by integration of core tools such as COMCOT and WRF, with the e-Infrastructure and providing the Web User Interface.

iCOMCOT portal provides the easiest web interface to simulate a tsunami event after defining the focal mechanism, simulation region and tidal stations only, since complex scientific configuration process are hidden. In addition, to speedup the simulation, iCOMCOT takes advantages of OpenMP computing model and distributed cloud resources over the e-Infrastructure. iCOMCOT is composed of five major components as depicted in Figure 3: web User Interface (UI), Common Gateway Interface (CGI), storage and database, workload management system as well as distributed computing resources. One could enter COMCOT simulation parameters, trigger the simulation, and obtain visualized results from the web user interface.

Figure 2. Architecture of iCOMCOT

The web portal of gWRF (grid-based WRF), developed by ASGC, utilizes the global grid computing resources for the weather simulation by the Weather Research and Forecasting (WRF) model. To improve the WRF overall efficiency, gWRF allows computing intensive WRF models to run on the Grid, whereas users handle WPS and post-processing which does not require lot of CPU resources. DMCC designed a package of scripts and made WRF MPI version running on EGI-based Grid infrastructure. Currently this service is only for users of EUAsia VO (i.e. to researchers from Asia-Pacific, and to their international collaborators). In the next release, the gWRF services will be opened to the global academic research community. The workflow of gWRF is depicted in Figure 3.



Figure 3. Workflow of gWRF

## Integration and dependencies

Tsunami propagation is a multi-scale problem, ranging from hundred kilometres to several meters. Cornell Multi-grid Coupled Tsunami Model (COMCOT) is a widely used tool developed by University of Cornell. COMCOT is capable of simulating the entire lifespan of a tsunami, from its generation, propagation and runup/rundown on coastal regions.

The iCOMCOT system provides a geographical user interface to easily identify the earthquake epicenter, observation stations, and simulation areas by making use of a web mapping services, such as Google Maps. The user only needs to define these parameters together with simulation name, simulation time, time period to save output data, focal mechanism, and nested-grid arrangement, then the simulation could be carried out by the portal. Among them, fault model, nested-grid and tide station settings will be kept in the system for future reuse.

iCOMCOT is a real-time tsunami simulation system which is fast, accurate, reliable, and user friendly. It proves to be an efficient and low-cost system for tsunami research, disaster mitigation and education, etc. for South China Sea countries. COMCOT is not used just for tsunami case studies of DMCC but also for the simulation of storm surge and typhoon events.

Weather Research and Forecasting (WRF) model is a state-of-the-art regional modelling tool developed at the NCAR. It has been designed to serve both operational forecasting and atmospheric research needs and it has a rapidly growing community of users all around the world.

Running WRF is not a simple task which involves execution of several pre-processing steps for the input data, initial conditions and boundary conditions. After the pre-processing, WRF core itself is computing intensive to generate simulation results of every certain number of time steps and output several result files. To hide the complexity of both Grid and WRF, gWRF provides the Web Portal Services to integrate numerical weather prediction tools and the e-Infrastructure. The long-term goal is to further simplify the workflow and leverage the performance of e-Infrastructure.

Policy of access to these two portals is open to collaborations for the moment. Users working on the target case studies, dissemination and infrastructure providers of DMCC are supported by default. Feedback of users to improve the web portal services as well as the workflow, e-Infrastructure and platform services are essential. Support for science education purposes for both teachers and students are also welcomed.

# Release notes

## *iCOMCOT Web Portal*

* + Version Number: 1.0
	+ Overview: iCOMCOT provides web portal services to simulate the entire lifespan of a tsunami, from its generation, propagation and runup/rundown on coastal regions, by the Cornell Multi-grid Coupled Tsunami Model (COMCOT).
	+ Date of release: April 1st, 2016
	+ System requirements: Web browsers in desktop, laptop or mobile device are all working.

## *gWRF Web Portal*

* + *Version Number: 1.0*
	+ *Overview: gWRF provides web portal services for numerical weather predication by the Weather Research and Forecasting (WRF) model developed.*
	+ *Date of release: April 1st, 2016*
	+ *System requirements: Web browsers in desktop, laptop or mobile device are all working.*

# Future plans

For the current target case studies of DMCC, gWRF is applied to storm surge, flood in Malaysia and Thailand, and also the forest fire aerosol transportation. iCOMCOT is used for storm surge and tsunami impact analysis. In addition, planned features for future releases are listed below.

1. Implement an interoperable Authentication and Authorization Infrastructure with levels of assurance by leveraging EGI technologies.
2. Accounting Service: to easily investigate how the resource is utilised considering both CPU and data flow.
3. Event database: For target case studies, compile event data, simulation method and simulation results and share on the portal.
4. Providing API to support flexible usage of the services and integration with user applications.